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AUTHOR	Borelli, Michael L.; Morelli, Sandra Z.
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ABSTRACT

Administrative concerns in implementing metrics at a district level are discussed and specific recommendations are made regarding them. The paper considers the extent and manner of staff training necessary, the curricular changes associated with metrics, and the distinctions between elementary and secondary programs. Appropriate instructional materials are discussed as well as their cost-effective acquisition. A detailed, rational implementation plan is offered. (MP)

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METRIC EDUCATION PROJECT

BOARD OF COOPERATIVE EDUCATIONAL SERVICES
McEVOY EDUCATIONAL CENTER
CLINTON AVENUE EXTENSION • CORTLAND, NEW YORK 13045 • TELEPHONE 607-753-9301

- ED167380

IMPLEMENTING METRICS AT A DISTRICT LEVEL

ADMINISTRATIVE GUIDE

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM."

by: Michael L. Borelli
Sandra Z. Morelli

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1979 REVISED EDITION

INTRODUCTION

The concerns of an administrator, or district administrative team regarding metrication are primarily logistic ones. The administrators must determine how to get the district from where it is presently, minimal metric activity, to where it needs to be tomorrow, predominantly metric. They must be familiar with the issues and their alternative solutions. Ultimately, they must be prepared to recommend an overall implementation strategy for the district, and defend that recommendation with Board members, parents, and community groups.

It is the objective of this paper to highlight those administrative concerns; and to make specific recommendations regarding them. While these recommendations may be appropriate for some districts, they will, in all probability, require adaptation to meet the unique circumstances which apply in many other districts.

THE ISSUES - an overview

What then are the issues with which district administrators need concern themselves regarding metrics? If we limit our consideration to just metrics, there are three: staff development, curricular revision, and the acquisition of appropriate instruction resources. However, "metrics" can be placed in a larger context - the teaching of "measurement" to children. There exists strong consensus that children acquire their measurement competencies through intellectual processes that stand in significant contrast to the way in which we have traditionally taught measurement to them. If we view the transition to metrics as an opportunity to reassess the pedagogy associated with teaching measurement to children, the issues cited above take on far more significance.

This paper discusses the transition to metrics in the larger context. It considers the extent and manner of staff training necessary to implement a revised measurement program in which the metric language of measurement is predominant. The curricular changes associated with metrics as well as those associated with revised measurement pedagogy are considered. Distinctions are drawn between elementary and secondary programs, both with respect to staff development and curricular impact. Appropriate instructional materials are discussed, as well as their cost-effective acquisition. Finally, a detailed, rational implementation plan is offered which provides for the coordination of the various components.

STAFF DEVELOPMENT

The staff development component of a metric implementation plan is probably the most critical aspect. Without the adequate and timely preparation of staff, no strategy however admirable it may otherwise be, can prove successful! The Interstate Consortium on Metric Education (ICME) was convened in 1974 to consider this and a number of other critical metrication issues.

Twenty-eight (28) state and territory representatives met. They developed a set of 23 recommendations, now generally regarded as reliable sources of metric guidance. Five of these recommendations speak to the inservice training of teachers (#'s: 19 through 23). This partial list of recommendations is attached as Appendix A.

Briefly the ICME recommendations indicate a need to distinguish between the inservice needs of elementary teachers and those of secondary teachers, between individuals directly involved in the teaching of measurement, and those concerned only with the general application of measurement. The recommendations suggest a 10 to 16 hour program for the former, while 3 to 6 hours are indicated as sufficient for the latter. They speak directly to the point that the teaching of metrics is a multi-disciplinary concern; that while the teachers of math and science should assume the major responsibility for teaching the metric system - teachers in all subject areas must assume the responsibility for teaching practical applications of metrics.

While the recommendations clarify to some degree the extent of training required by various staff members, they do not speak to an issue of comparable concern to the administrator, namely how a district is to go about getting all those people trained. There are several alternatives: in-house training through inservice course, workshops, and seminars or external training through university sponsored programs. Teachers should, ideally, be required to demonstrate to the satisfaction of the administration that they possess the required competencies. However, they should have the option of acquiring these through whichever route seems most feasible.

The district, or several districts can offer an inservice course. This 10-15 hour experience should teach teachers about metrics in the same manner that we hope they will later teach students (hands-on, activity-oriented experiences supplemented with lectures). It should precede curricular implementation, but not by such an extensive period as to make the training lose immediacy. In addition to teaching them "metrics", it should also expose them to optimal instructional strategies for teaching "measurement" to children. A number of models for such an inservice course already exists (California, Hawaii, ICME,...). We have attached as Appendix B a rough outline of the course presented in conjunction with the metric project we are conducting.

Not all staff members require training as extensive as that provided by an inservice course. Additionally, there are local needs that such a course would be unlikely to meet, especially if offered on a multi-district level. Therefore, it is appropriate to supplement the inservice course with a collection of workshops. Included among these workshops should be a general awareness session appropriate to all staff in the district. This would detail why the metric system is coming, the basics of its language, and the impact it will have on schools. Such a presentation should precede all other metric activity within the district. It would also be advisable to include within this presentation the overall district implementation plan.

There should also exist a collection of topical workshops (Metrics and Industrial Arts, Metrics and Language Arts, etc.) that would form the basis for the inservice training of secondary teachers. These would supplement the general awareness presentation described above. Their specific format would be a function of the disciplines they serve; they might generally include hands on activities with metrics (1-3 hours depending upon need) followed by an exploration of the specific impact metrics would have upon that subject area.

While most teachers recognize that inservice training is a professional responsibility, there are, nevertheless, some who will fail to view it this way. The inservice course is the ideal vehicle for delivering the requisite 10-15 hours of training to those staff members requiring (or desiring) it. Not all staff members, however, will opt for such an experience. Unfortunately, those who are least likely to register for such a program, are probably the ones who most need it! While it may be tempting to require these "reluctant learners" to attend - this practice cannot be recommended. There exists an alternative with a higher degree of probable success. Require those staff members for whom extensive metric training is essential (teachers of measurement) and who cannot demonstrate that they have acquired the required metric competencies (locally or externally) to attend a mini-course (3-5 hours in duration). While such a mini-series is not totally adequate, it should serve the function of reducing some of the anxiety and thus paving the way for future training of the staff members. It will prepare them adequately to begin to use metrics in their classrooms. Supplemental training may be required at a later date.

An additional concern with respect to staff development is a purely logistic one: How do you get the training accomplished? Who to select as trainers is probably the most critical decision. There are presently in New York State a very limited supply of individuals qualified to present such programs. However, the fruits of their labor, are for the most part, public domain. Inservice packets should eventually be available from Title IV-C projects, SED Math Bureau, etc. Key individuals within districts should, with these materials and adequate training, be able to then present such programs.

Another alternative which districts need to consider is to allow teachers to acquire the metric competencies they will need through university sponsored courses or workshops. The universities could also serve as facilitators in providing training at the local level. The viability of such options is, of course, a function of the proximity and sensitivity of appropriate institutions, and will vary widely from district to district.

The final concern for staff development is fiscal. The costs associated with this activity will vary according to the strategy elected, local inservice remunerative policies, whether the services are cross-contracted with BOCES or provided solely by local initiative, etc. Costs associated with consultant services, supplies, and materials for training need also to be factored in. As a purely "ball-park" estimate, based upon various experiences, we would estimate that costs should range somewhere between $5 to $10 per staff member in the districts, plus any monies the district would offer teachers for inservice training.

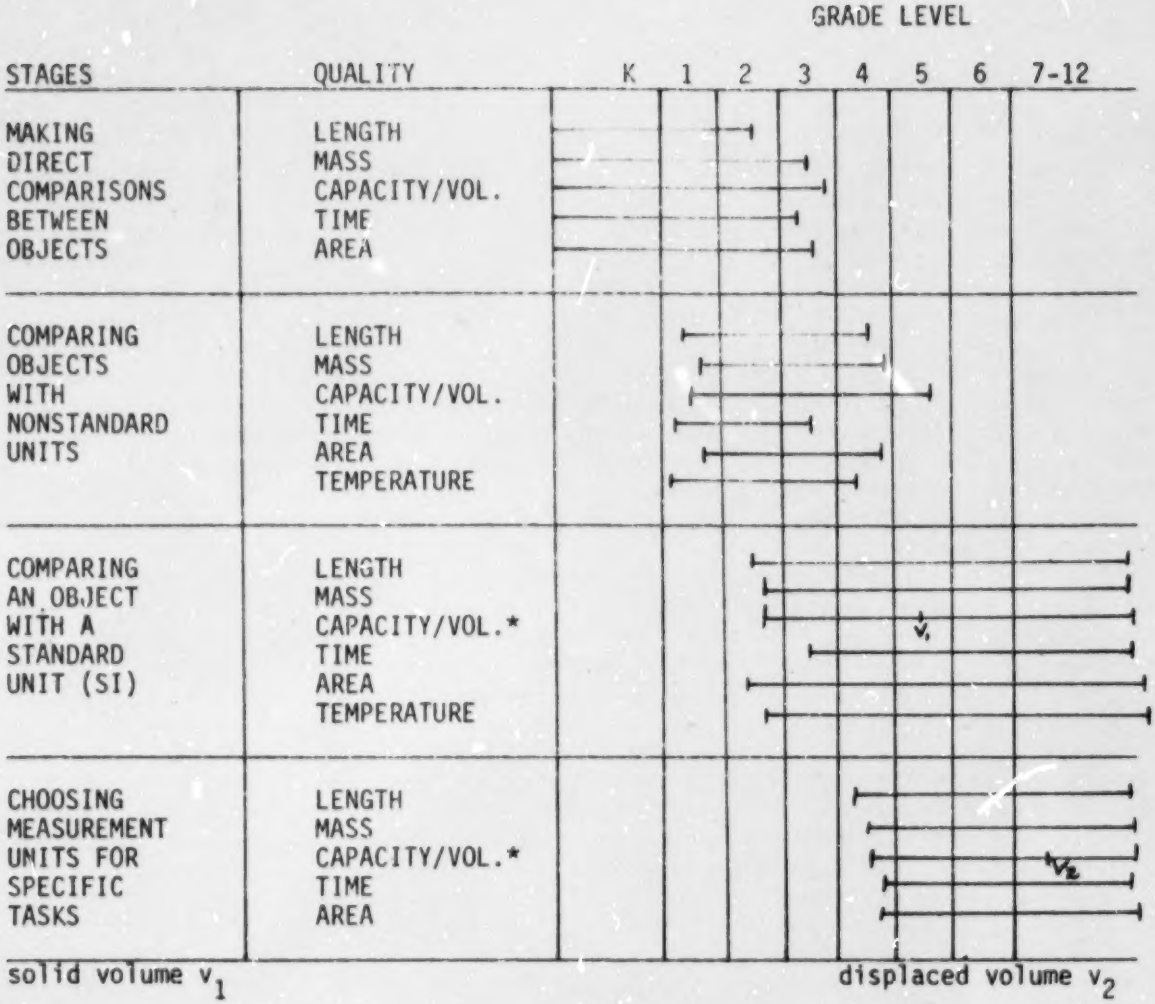
CURRICULAR REVISION

Changing our nation's measurement language from Imperial inches, quarts, and ounces to metric meters, liters, and grams will clearly have a significant impact on school curricula. The extenT will be determiend largely by the age (grade level) of the student, and the context in which the instruction is taking place.

Mere replacement throughout the school curriculum of every instance of "inch", "quart", and "ounce" with their metric counterparts represents the least complex, and most easily accomodated implication of "going metric". However, going metric provides educators a unique opportunity to reassess the manner in which we have taught our students measurement skills. Such a reassessment should assure us, as it did the National Assessment Team, that there exists significant room for improvement.

Based upon the research of Piaget, Copeland, Lovell, the Nuffield Project, etc., educators are now aware that there exists better ways to instruct young people in measurement. Any transition to metrics within a district should also include within it a general restructuring of the measurement strand within the elementary intermediate program based upon the above information. This impact of "going metric" will, in all probability, be more complex, require more pre-planning and yet be more significant than the "replacement" impact cited earlier.

While it is difficult to encapsule changes as comprehensive as this type of restructuring suggests, the chart on the next page attempts to summarize them. We now recognize that children acquire their measurement competencies in intellectual stages. We also realize that until such time as a child comes to "conserve" a particular measureable quality of an object, that it is inappropriate to teach that child a standard unit related to that quality. We, therefore, devote the primary grades to helping young people clearly perceive the qualities to be measured by having them compare and distinguish those qualities in many contexts. Students are lead through a sequence of activities allowing them to quantify various attributes first with the use of non-standard units. Depending upon the ages at which they come to "conserve" various qualities, standard metric units are phased in. This transition usually begins around grade three.



If the recommendations of the researchers are to be fully implemented, then measurement instruction would be predominantly activity-oriented. Such instruction would reflect the various stages through which children must progress in acquiring their measurement competencies. Additionally, it would avoid totally conversion exercises between metric and imperial systems, while recognizing the need for some time to come for bilingual measurement instruction. However, metric instruction would be first and foremost, with imperial units being taught as a second language.

Another significant factor associated with the restructuring of the elementary measurement strand, is the co-requisite need to restructure the arithmetic strand. Metrics is, by its very nature, a decimal language of measurement. Instruction in decimal numerals, therefore, can no longer wait until grade 5 or 6. Most restructurings place decimal numerals into grade 4 or lower. Given the close similarities between the algorithms for whole numbers and those for decimal numerals, improved mastery can be anticipated. Details regarding the objectives by grade

level should be forthcoming from local state education departments in the very near future. States such as California and Hawaii as well as several districts within New York have models upon which programs could be based.

A change clearly related to the earlier placement of decimal numerals in the math curriculum, is the realignment in that same curriculum of common fraction. Instruction in fractions can be divided arbitrarily into two categories: conceptual and algorithmic. Students will continue to require familiarity with the concept of common fractions. As it becomes more apparent that applications of fractional algorithms are little used in practical situations, the teaching emphasis of this category will decrease. We may find future state math curricular revisions moving in this direction. Ideally this trend would eventually yield an elementary school program concentrating on instruction related to the concept of a fraction (through the use of concrete models) and on the equivalence of fractions and between fractions and decimals. Ideally, instruction of fractional algorithms would then be offered in a pre-algebra program at the junior high school level.

Virtually all other curricula areas in the K-12 program need only concern themselves with the "replacement" impact that conversion to metrics will have on their program areas. A home economics class still has at its basic objectives a certain set of performance skills. These skills are unaffected by changes in measurement language. The same could be said for virtually every other area. This is not to imply that only the elementary math teachers will be affected. Teachers in secondary programs will need to assess to impact replacing one language of measurement for another will have on their programs. For some, this impact will be minimal, for others it will be more significant. But for almost no area will the impact be non-existent.

Those districts revising their curricula or planning to do so, can seek assistance from a number of organizations. The State Education Department has published some curricular guides in many areas (e.g. elementary math 1-3, home economics, etc.) which may be obtained through the various bureaus. The state has also funded metric education projects throughout the state under ESEA Title IV-C (eg. Project MEASURE, CMEP). Over the past 3 years, the U.S. Office of Education has funded many projects around the country which deal particularly with metric curriculum. The National Council of Teachers Mathematics also has produced many fine guides for schools or have recommended other sources which will aid districts in their curricular revisions.

INSTRUCTIONAL RESOURCES

Introducing metrics into a district's instructional program will require the district to provide its staff with appropriate resources for use in the classroom. Above all others, it is this requirement which usually meets with vocal protestations from community groups and boards of education.

They probably envision every book, paper, and piece of equipment in the building being loaded on a dump-truck, all to be replaced with nice, new, expensive goodies. They are frequently countered by the metric prophets preaching conversion at virtually no cost. The truth lies somewhere between those extremes.

Resources affected by metric conversion include: text books, audio-visual aids, maps, charts, measurement instruments and instructional supplies.

Virtually all of these presently within the district, have given life expectancies. For example, most school purchased text books have a life expectancy of approximately five years. In phasing metrics into a district these life expectancies should be taken into consideration - don't adopt a new text book series the year before you revise a sensitive curriculum. Supplement existing texts with teacher materials, as long as it is feasible to do so.

There are some items that will have to be purchased, particularly measuring instruments new to the elementary classroom. These do not all have to be purchased the first year, and can be phased in with the instructional program. The chart in Appendix B details what resources would be appropriate for math or science classrooms where the primary responsibility for teaching metrics is placed. Other listings are available.

Some materials we have listed may already be in your classrooms. Districts should take careful inventory prior to purchasing any new materials. In some instances existing materials can be adapted for metric use. A word of caution is in order, however, avoid dual labeling. Such practices have been shown to be clearly counter productive! There are some exceptional situations in which this is unavoidable, especially in I/A - Occupational Education - Home Economic contexts.

In industrial arts it is not necessary to buy metric replacements for all customary measurement tools. We will be bilingual for some time to come, therefore, we need only phase metric (or dual) instruments in over time. Replace customary tools gradually with ones using metric calibration.

Specifically, in drafting the only pieces of metric equipment needed are scales and templates, continue customary paper sizes for some time. Woodworking conversion costs are generally low as no machines need to be replaced. Measurement tools are needed, with existing machinery easily adapted for the transition. Metric costs are higher in the metal-working area than in any other. Costs can be extended over many years, with highest priority instruments being acquired first. Conversion kits for lathes and mills are expensive, difficult and hard to install; considerable research should precede any purchase. The needs of individual programs will determine what and when to buy. Steel rulers, micrometers, calipers, thickness gauges are among the required metric tools.

While graphic arts and printing are measurement sensitive areas, very few metric replacement tools are needed to provide students with basic metric experiences. Hand tools such as wrenches, gauges, and rulers are the primary items needed for basic metric activity in power, energy and automotive work. Many automotive shops already carry a full line of metric tools. Since electrical units are already metric, no new tools are needed there. Further information regarding this aspect can be obtained from the Center for Metric Education at Western Michigan University.

IMPLEMENTATION PLANNING

If a district is to implement a revised metric instructional program, it is essential that it do so through a carefully designed plan. The staff development, curriculum revision, and instructional resource components must dovetail if the plan is to be effective. The plan, itself, can be developed at any level within the district; but might best be developed by a district-wide group with input from as broad a spectrum of the school population as feasible (administration, teachers, students, parents...).

The plan should include a clearly defined time-line for its major events. This time line should be well publicized, so that all sectors of the community are well aware of it. Meetings with parents, community groups, boards of education, devoted to the why and wherefore of metrics are strongly recommended to galvanize the type of community support so essential to an effective transition to metrics.

While community support is significant, the plan must ultimately come to have full administrative support. The administrative commitment to the plan, more than any other single factor, determines its probably success in the field. Such commitment derives from a thorough understanding of the issues, the alternative solutions, and the rationale supporting the options elected. Administrative workshops can meet this need.

The plan should clearly delineate responsibility and authority for monitoring and evaluating the implementation in an ongoing manner. Unless some individual within the administrative group is clearly delegated the authority to follow-up on metric implementation, the plans will tend to fizzle.

The number of years over which the plan itself extends is, of course, subject to a number of variables. The Interstate Consortium on Metric Education has recommended September, 1980 as a general target date for the educational community, with the objective being a "predominantly" metric instructional program. New York State has a similar target date. The state math bureau plans to publish its revised K-6 curriculum (predominantly metric) by 1980 which is reasonably close to the desired implementation date. Bureau of tests and measurements indicates that revisions are planned for PEP and Basic Competency tests in future to reflect corresponding changes in measurement language, but are unable at this time to provide specific target dates. It would appear from all available evidence that most states and agencies within New York State are targeting for the early 1980's. Thus, we are talking about an implementation plan which covers two to five years depending upon local circumstances.

Most text books companies have been leaders in the education field in terms of metric classroom instruction. The most recent publications (after 1977) have demonstrated a conscientious incorporation of metric writing styles and activity oriented instructional techniques. All major publishers have phased in metric instruction as a primary measurement unit in their texts with some being as much as 80-100% metric. The publishing companies have also planned to update their standardized testing program.

The IOWA tests of basic skills, Metropolitan and Stanford Achievement tests have plans to increase metric questioning; some as early as 1982. These implementations largely depend on coordinations with current texts and states' syllabi.

It should be noted that two psychologically appealing alternatives have been rejected: a twelve year, grade-by-grade phase in and a one year, "overnight" transformation. The former because it clearly will take too long and consequently would fail to accomodate our needs; the second because it has consistently proved an unworkable solution in those few places where, incredible as it may seem, it was tried!

Given the above constraints, a basic implementation plan follows. It extends over 4 phases. Each phase could reasonably take one year to complete but could be accomplished in a shorter period of time. It provides for staff development, curricula revision, and resource development in three stages: K-3, 4-6, 7-12. These three partitionings were chosen because the nature of the tasks within each are quite similar.

Implementing metrics in the K-3 division should be accomplished with a minimum of confusion. It is not until well into the third grade that instruction in metric units per se becomes significant. Prior to that teachers are charged primarily with developing measurement concepts in general, irrespective of any language of measurement. K-3 teachers have dealt with this curricular issue traditionally, and are easily sensitized to the newer strategies and vocabulary. Given the understandable frustration they have historically experienced in attempting to teach standard imperial units, most are quite amenable to discontinuing that practice in place of non-standard units. The new resources required are minimal, and can easily be integrated into existing resource budgets.

The 4-6 modifications, on the other hand are the most fundamental within the overall school program. They will require the greatest amount of staff development and curricular revision. Their implementation will need careful monitoring - staff will require much support. This aspect could, therefore, stretch over as much as two years.

The 7-12 segment is primarily a "replacement" revision, and can, therefore, be accomplished again with a minimum of confusion. Staff development needs are less comprehensive, but more highly specialized. Material resource needs range from nominal to substantial and require discipline by discipline consideration. The overall plan at this level is, consequently, much more significantly compartmentalized and specialized.

The plan also provides for a full year of preparatory planning and development prior to the implementation of any revised curricula. Such lead time is essential if confusion is not to be the end product.

Needless to say, as with any such plan, there exists considerable room for modification, adaption to local situations and circumstances. School organizations might dictate a different partitioning, or current levels of involvement might allow considerable foreshortening, etc. Good judgement clearly will dictate the precise nature and scope of any locally developed plan. That which follows is merely to form a rationale strategy for changing the language of measurement used within a school district:

IMPLEMENTATION STRATEGY - a sample plan

Phase #1

- develop district-wide awareness of overall plan, rationale
- adopt Board policy and supporting administrative guidelines (Sample Appendix C)
- conduct administrators' workshops (central & elementary administration)
- intensive staff training K-3
- curricula adjustments K-3 clarified
- acquire instructional resources K-3

Phase #2

- implement K-3 revised program and MONITOR
- continue administrative workshops: K-3 supervision of metric instruction
  4-6 developing metric curriculum
- intensive staff development: 4-6
- teacher workshops K-3, support
- curriculum revision 4-6
- instructional materials 4-6
- parent workshops K-3

Phase #3

- implement 4-6 revised program, MONITOR 1-2 years
- administrative workshops: K-6 supervision of metric instruction
  7-12 implementing metrics at secondary level
- staff development 7-12: General Awareness
  Special topical workshops
- revise curricula 7-12
- acquire instructional resources 7-12
- teacher workshops 4-6, support
- parent workshops 4-6
- Adult Education courses offered

Phase #4

- implement revised programs 7-12
- MONITOR K-12
- workshops 7-12, support
- continue community workshops

The overall plan could extend over a 2 to 5 year period depending on the time allotted for each phase. It should be noted that if each phase is implemented over a one year period, the above plan will not provide for our present 6th through 12th grades as they are always ahead of the phase-in. Special consideration needs to be made for this group of young people, all of whom are destined, just like the rest of us, to live in a world that clearly will eventually be a metric world.

Their training needs will be similar to those of any adult already fluent in the imperial language of measurement. They will need to be taught what they will use in everyday applications in the real world, not the entire metric system. Such training, not unlike that of younger children, however, should be as activity oriented as possible. The only way to learn metrics, is to measure, estimate and verify using metric units - as opposed to hearing about metrics. Secondary Mathematics or science teachers could, with a minimum of training, provide the essential experiences to these students prior to the general implementation at the secondary level. The activities designed might also be appropriate for use in adult education and parent training workshops.

APPENDIX A

Extracted from Interstate Cornsortium on Metric Education - Final Report published 1975 by the California State Department of Education

Recommendation 19

The ICME recommends that preservice and/or inservice education programs be designed to prepare elementary teachers, administrators, and support personnel involved in instruction to implement measurement using metric units. The recommended program includes two areas of concern: (1) metric awareness; and (b) metric measurement experiences for teachers and aides.

Rationale: The rationale for Recommendation 19 is presented in detail on pages 14 through 16.

Recommendation 20

The ICME recommends that preservice and/or inservice training programs for teachers at the secondary school level (grades 7 through 12) be designed to help these teachers become aware of the basic content and learning principles used in the elementary metric programs. In addition, secondary training programs should contain more concentrated, in-depth treatment of measurement for teachers in specialized areas. These specialized areas are: (1) vocational/technical education, including industrial arts, home economics, and related fields; and (b) mathematics and science.

Rationale: The rationale for Recommendation 20 is presented in detail on pages 14 through 16.

Recommendation 21

The ICME recommends that state educational agencies provide leadership by developing a core of resource personnel whose responsibility will be to implement metric education programs at the local level.

Rationale: The need for implementing a variety of metric education programs at the local level necessitates the training of resource personnel who can carry out these programs effectively. A core of resource personnel could be trained and then in turn train others to assist in implementing metric education programs all the way to the local school level.

Recommendation 22

The ICME recommends that measurement inservice programs for individuals directly involved in teaching measurement to students be of 10 to 16 hours duration. Introductory inservice programs of 3 to 6 hours duration on metric measurement should be designed for all individuals involved in instruction. In both programs, "hands-on" activities should be emphasized.

Rationale: This recommendation is needed to identify the amounts of time that are adequate for the accomplishment of the objectives for the various types of preservice and inservice programs.

Recommendation 23

The ICME recommends that (a) mathematics and science teachers assume the major responsibility for teaching the metric system; and (b) teachers in all subject areas assume the responsibility for teaching applications of the metric system.

Rationale: Teaching the metric system is a multi-disciplinary concern.

SUPPORTING RATIONALE FOR RECOMMENDATIONS 19 AND 20

SUGGESTIONS FOR TEACHER INSERVICE TRAINING

In addition to its official recommendations, the ICME developed suggestions concerning the implementation of preservice and inservice teacher-training programs at the elementary and secondary school levels. Two areas of concern that were identified regarding both the elementary and the secondary level programs were (1) metric awareness programs; and (2) experiences with metric measurement for teachers and aides.

INSERVICE TRAINING FOR ELEMENTARY TEACHERS

To fulfill the intent of the elementary school preservice and inservice recommendation (Recommendation 19), the ICME suggests that the following components be incorporated into metric awareness programs:

1. HISTORY - A brief historical background on measurement should be presented that includes progress made in the implementation of SI metrics at the local, state, national, and international levels.

2. ADVANTAGES OF THE SI METRIC SYSTEM - The advantages of SI metrics that teachers should be aware of include (a) SI metrics is based on decimal numeration similar to the U.S. monetary system, and the SI system is therefore easy to understand and use; and (b) the coherence and simplicity of SI metrics are factors that have contributed to its official acceptance by approximately 90% of the world's population.

3. RESISTANCE TO CHANGING TO SI METRICS - Teachers should be prepared to expect some natural resistance to the acceptance of the SI metric system and should be able to cope with this resistance in a positive manner.

4. INTRODUCTION TO SI METRIC UNITS - Teachers should have the opportunity to use common SI metric units, such as by holding a kilogram mass.

The ICME suggests that experiences with metric measurement for elementary level teachers and aides include the following:

1. Activities similar to those in which students will be involved. The activities should range from free exploration with a variety of materials to such structured exercises as the following:

   a) Measurement activities directly related to real world situations
   b) Construction and use of simple measurement devices
   c) Games, puzzles, and problems to develop and reinforce the basic concepts and skills of measurement and to achieve proficiency in conversion techniques within the metric system

2. Informal and formal diagnostic techniques that enable the teacher to determine the level of conceptual and skill readiness of students.

(con't.)

3. Experiences that enable teachers to acquire a knowledge of the prefixes, symbols, and notation terminology used in SI metrics

4. Experiences that enable teachers to use a variety of community resources

5. Opportunities to examine a variety of learning materials for measurement

INSERVICE TRAINING FOR SECONDARY TEACHERS

To fulfill the intent of the secondary school preservice and inservice recommendation (Recommendation 20), the ICME suggests that the following metric subjects be treated in metric-awareness programs:

FOR ALL TEACHERS IN GRADES 7 THROUGH 12
- Historical background
- Legal status (federal, state, and local)
- Implications of metric implementation (national economy, education and consumer)
- Familiarity with units of length, mass/weight, time, temperature, volume/capacity, and speed
- Decimal system of numeration (similarity to U.S. monetary system)
- Metric prefixes and symbols
- Issues and concerns

FOR VOCATIONAL/TECHNICAL TEACHERS

- Familiarity with essential metric units, prefixes, and symbols
- Industrial uses
- Mass-weight clarification
- Other skills needed for specific subjects
- Funding opportunities

FOR MATHEMATICS AND SCIENCE TEACHERS
- Technical definitions of base units
- Derived and supplemental units
- Scientific notation

The ICME usggests that experiences with metric measurement for teachers and aides include the following topics:

FOR ALL TEACHERS IN GRADES 7 THROUGH 12
- Personal measurements
- Estimations and verifications
- Error in measurement and approximation
- Travel distances
- Selection of appropriate units
- Construction and calibration of measuring instruments
- Practice with measuring

(con't.)

Conversion within metric system
Unit pricing practices
Criteria for selection of instructional materials

FOR VOCATIONAL/TECHNICAL TEACHERS
Vernier scales
Metric (radial) protractors
Map and scale drawing skills
Mensuration formulas
Instruments used in specific courses
Visitation of exemplary programs

FOR VOCATIONAL/TECHNICAL TEACHERS AT THE SENIOR HIGH SCHOOL LEVEL ONLY
More sophisticated instruments
Conversion skills needed for specific courses

FOR MATHEMATICS AND SCIENCE TEACHERS
Very small and very large units of measurements
Application of time units
Factor label/unit analysis
Map and scale drawing skills
Mensuration formulas
Instruments used in specific courses
Visitation of exemplary programs

FOR MATHEMATICS AND SCIENCE TEACHERS AT THE SENIOR HGIH SCHOOL LEVEL ONLY
Derived units as needed
General physical constants
Derivation of physical formulas
More sophisticated instruments
Conversion skills needed for specific courses

APPENDIX B

A Suggested List of Measurement Materials
Grades K-6

To implement "metrics" in the K-6 math/science programs the following mterials would be appropriate. Not all materials would be needed in each classroom, some could be shared - such materials are indicated with an asterisk. All numbers are for a class of 30, shared materials for 3 or fewer classes.

Description	Sharing possible	Grades K-1	2	3	4-6	Approx. Cost
Meter stick (no calib.)		1	1	1		$ 3.00
Meter stick (cm calib. K-4)	*		15	15	15	3.00
30 cm ruler (cm calib. K-4)			30 primary calib.	30 primary calib.	30 intermed. calib.	.50
Teacher's demo meter stick (4 sided)			1	1	1	5.25
Vinyl tape measure (150 cm)			10	10	10	.50
30 meter tape	*			1	1	20.00
Trundle Wheel	*		1	1	1	13.25
Wall height chart		1	1	1	1	2.75
Primary Balance (bucket)	*	1	1	1	1	13.00
Elementary Balance (pan)	*		1	1	1	27.00
Platform Spring Scale (dial)					1	14.00
Package Centicubes (1,000)		1	1	1	1	20.00
Stacking Plastic Masses (set)			1	2	2	4.00
Elem. bar mass pieces (set)	*		1	1	1	15.00
Kg mass pieces		1	1			3.50
Set precision mass pieces	*				1	5.75
Mesh weighing bags (pkg. 10)		1	2	2	2	2.50

Description	Sharing possible	Grades K-1	2	3	4-6	Approx. Cost
Personal (bath) scale	*	1	1	1	1	$12.00
Pull spring scales				4	4	3.25
Liter measuring pitcher			1	2	2	4.25
Multi-shape liter set	*		1	1	1	13.00
Plastic liter box - graduated	*		1	2	2	3.50
Measuring spoons set		1	1	2	2	.75
Measuring cup set		1	1	2	2	1.50
Graduated cylinders or beakers (set)	*			1	1	6.00
Outdoor thermometer	*	1	1	1	1	2.50
Aluminum-backed student thermometer		1	1	10	10	@1.00
Demonstration thermometer	*	1	1	1	1	7.00
Indoor wall thermometer		1	1	1	1	2.00
cm^2 graph paper (ream)				1	1	5.00
cm^2 acetate grids	*				15	@.25
Approximate costs without sharing between classes or grades		$100.	$240.	$300.	$325.	

APPENDIX C

Guidelines for Metrication

IT IS THE POLICY OF _____

School District that:

1. The metric system become the principal system of measures in the curriculum of the elementary and secondary schools of the district.

2. Metric conversion be implemented in the schools with the express intention of ensuring that programs of instruction become predominantly metric by September, 1980.

3. Metrication be applicable to all areas of the curriculum and that all measured quantities, wherever appropriate be stated in metric units.

4. The units and symbols of the metric system taught in the schools conform to those of the International System of Units, known as S.I.

5. Metric education be accepted as an opportunity to reassess pedagogical approaches of the topic of measurement as a whole; that students be provided with opportunities to acquire a practical and experiential knowledge of metric units through activities that involve comparing, estimating, measuring, and related problem-solving.

6. Metric changes in the curriculum be coordinated with corresponding changes in industry and commerce.

7. Metric conversion of learning materials in the schools be carried out on a pre-planned and gradual basis; with due consideration being given to the attrition, modification, and replacement of materials, as well as to the availability of new learning materials.

CMEP - Comprehensive Metric Education Project
Inservice Course: Outline by Session

Session #1 Pre-test - competency with metric measure, style guidelines, appropriate measurement teaching techniques.

Lecture - Awareness Extended: why metrics, its impact, an overview of the system

Activity #1 - Style guidelines: conventions applied in the writing of metric measures.

Session #2 Lecture - How Children Learn to Measure: educational research and theories of learning, especially as they relate to the way in which young children acquire measurement competencies.

Activity #2 - Using Non-standard Units: a measurement experience using non-standard units of length which leads the participant to an understanding of standard units.

Session #3 Lecture - Precision in Measurement: a discussion of the approximate nature of measurement, and the limits of precision inherent to any measurement device. The reading of linear scales is also considered.

Activity #3 - A Metric Rule: each participant builds and calibrates their own metric stick or tape; uses the instrument to make a number of measurements. Participants then estimate and verify a number of measures.

Session #4 Lecture - Estimation in Measurement: a discussion of the critical role estimation plays in learning, internalizing a unit of measure. This is followed by a consideration of metric-metric conversions.

Activity #4 - Area: participants use non-standard units and then area grids to determine the area of several regions. Later they estimate and verify areas of others in: cm^2, mm^2, and m^2.

Session #5 Lecture - Teaching Children To Measure I: some pedagogical guidelines for teaching measurement to children, related more to process than content.

Activity #5 - Volume I: the concept of volume is developed first through direct comparison, then through the use of non-standard units. Metric units: cm^3 and m^3 are then considered. Displaced volume is also dealt with briefly.

Session #6 Lecture - Teaching Children to Measure II: some curricula guidelines for teaching and applying measurement K-12.

Activity #6 - Volume II: activity #5 is extended to include metric units of "wet" volume: litre and millilitre. Participants estimate and verify volumes of a number of vessels. Metric "spoons" and "cups" used in cooking also considered.

Session #7 Lecture - Teaching Children To Measure III: activities consistent with pedagogical and curricula guidelines previously presented are considered. Specific activities for a number of objectives are presented.

Activity #7 - Mass I: the concept of mass is developed through direct comparison of a number of objects. Participants develop a non-standard unit of mass and use it to determine the mass of several objects. The gram is introduced using centicubes.

Session #8 Lecture - Instructional Resources: a consideration of what resources are available, what is needed, what would be nice to have, as well as what isn't needed. Criterion for the selection of resources are developed.

Activity #8 - Mass II: participants determine the mass in metric units (grams and kilograms) of several objects. Competency is developed through estimation activities.

Session #9 Lecture - Temperature and Derived Units in the Metric System: a quick overview of other commonly used units in the metric language, their relative magnitude and some rules of thumb for getting a handle on them.

Activity #9 - Metric Madness - surprise!

Session #10 Lecture - Open Discussion: implementing metrics in the classroom.

Activity #10 - Post-test: competency with metric units, attitudes toward metrics, frequency of metric utilization.